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Novel High Gain Terahertz Antenna design Employing FR4 as Substrate for the Detection of Vitamin K2

Roopan[1], Raveena Bhatoa[2], Ekambir Sidhu[3]

UG Student, Department of Electronics and Communication Engineering, Punjabi University, Patiala, India[1]

UG Student, Department of Computer Engineering, Punjabi University, Patiala, India[2]

Assistant Professor, Department of Electronics and Communication Engineering, Punjabi University, Patiala, India[3]

ABSTRACT: This paper presents the design and analysis of terahertz microstrip patch antenna for the detection of vitamin K2 applications. The proposed antenna has been designed and fabricated using flame retardant-4 (FR-4) having dielectric constant (ε_r) 4.4. A flame retardant-4 (FR-4) has been used as substrate material with thickness 1.62 µm and the size of 30*30 μm^2. The proposed terahertz antenna has been designed and simulated using CST Microwave Studio 2016. The proposed terahertz antenna has been analyzed in terms of return loss, impedance bandwidth, gain, directivity, Half Power Beamwidth (HPBW) and Voltage Standing Wave Ratio (VSWR). It has been observed that the proposed antenna has a gain of 5.649 dB, directivity of 5.476 dBi with return loss -41.53 dB at 3.87 THz resonant frequency with minimal losses. The antenna radiates with resonant frequency of 3.87 THz having impedance bandwidth of 99.8 GHz. The antenna has VSWR equal to 1.01. The proposed antenna design has HPBW of 87.6 degree. The microstrip feed line technique has been used for proper impedance matching (50 Ohm) with SMA connector.

KEYWORDS: CST Microwave Studio, HPBW, Return loss, SMA connector, Terahertz, VSWR, Vitamin K2.

I.INTRODUCTION

The antennas are the backbone for wireless infrastructure which was first demonstrated in 1901 by Marconi [1][2][3]. Antennas following this trend, have to be compact and must be incorporated with host object with desired impedance behavior and radiation characteristics [4]. The microstrip patch antennas have been widely used in high performance satellite and wireless communication devices because of their low cost, low profile, light weight, ease of fabrication and compatibility of integration with circuit technology [5]. Microstrip antenna, also known as patch antenna or printed circuit antenna. Themicrostrip patch antenna is usually fabricated on a FR4 substrate sandwiched between a conducting patch and a conducting ground. The patch can be designed in many shapes like rectangular,circular, triangular, elliptical, square, ring and many more but the rectangular shape is widely used [6] because of its simplicity associated with the design. MPA have successfully covered a diverse range of applications like IMT,Bluetooth,WiMAX, WLAN[7][8], satellite communication [9],security and biomedical purposes [10].The THz region is the frequency spectrum between 0.1 THz and 10THz terahertz waves lying between microwaves and infrared radiation. The wavelength range of terahertz frequencies is from 30µm to 3mm.
There are various factors contributing to the increasing interest in terahertz frequencies as mentioned below: [11][12]

(a) The terahertz radiation can go through opaque barrier such as packaging, corrugated cardboard, shoes, book bags, clothes etc. in order to explore dangerous material contained within.

(b) Many materials for security applications and including explosives and chemical biological agent have characteristics THz spectra that can be used to fingerprint and identify these hidden materials.

(c) The terahertz system doesn't harm to suspect being scanned under terahertz radiation.

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Section II (Antenna Geometry) describes the geometry of the proposed antenna including side view, top view and bottom view of antenna illustrating the dimensions of patch, substrate and ground plane.
Section III (Simulated Results) describes the competency of designed antenna in terms of return loss (S11), bandwidth, gain, directivity, VSWR, HPBW and impedance.
Section IV (conclusion) proposes the suitability of designed antenna for various applications.

II.ANTENNA GEOMETRY

The proposed terahertz microstrip patch antenna has been designed and simulated using CST Microwave Studio 2014. The foremost layer of the proposed antenna is the radiating patch made up of copper as shown in fig.1. The fig.1 presents the top view of the proposed antenna.

Figure 2 represents the bottom view of the proposed antenna. In the proposed antenna design, the substrate of thickness 1.62μm has been employed. The rectangular substrate is of Flame Retardant-4 (FR-4) material having dielectric constant of 4.4 has been employed. The arrangement of substrate, patch, ground and feedline is as shown in fig. 3. Figure 3 shows the side view of the proposed antenna.

The power to the proposed antenna is fed by co-axial SMA connector via feedline. The SMA connector used to feed power has impedance of 50Ω, thus the Impedance of the illustrated antenna design has been matched to 50Ω so as to minimize the back reflection of the power fed through the SMA connector.

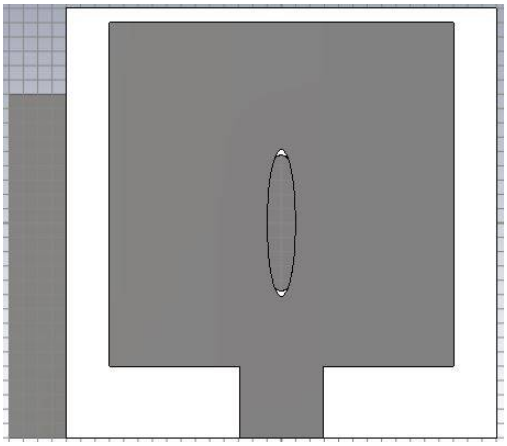

Fig. 1 Top view of the proposed antenna

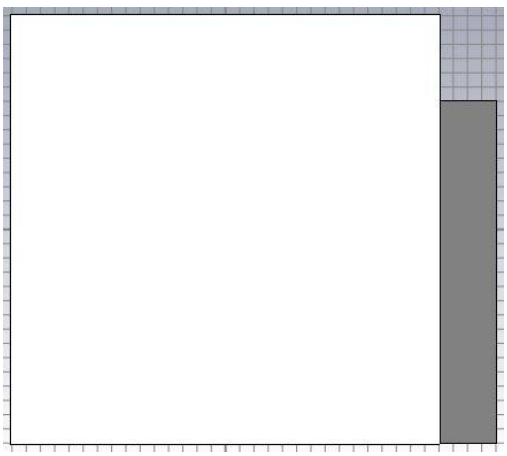

Fig. 2 Bottom view of the proposed antenna

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Fig. 3 Side view of the proposed antenna

III.SIMULATED RESULTS

The proposed antenna has been simulated using CST Microwave Studio 2014.The analysis of proposed antenna design has been done in terms of resonating frequency(GHz), return loss(dB), impedance(Ω), VSWR,gain(dB), directivity(dBi) and HPBW as shown in Fig.4, Fig.5, Fig.6, Fig.7, Fig.8 and Fig.9 respectively. It has been observed that the return loss is -41.53 dB at the resonating frequency of 3.87 THz. The simulated bandwidth of proposed antenna is 99.8 GHz. The Smith Chart plot indicates the variation of impedance of the antenna with frequency. The value of impedance should lie near 50 ohms in order to perfectly match the port impedance with the antenna impedance for maximum transfer of power to antenna. The antenna impedance for the proposed antenna is 50.6Ω. The proposed antenna has gain of 5.649 dB and directivity of 5.476 dBi.It has been observed that the VSWR value of the proposed antennas lies below the maximum acceptable value of 2. The value of HPBW is 87.6 degree.

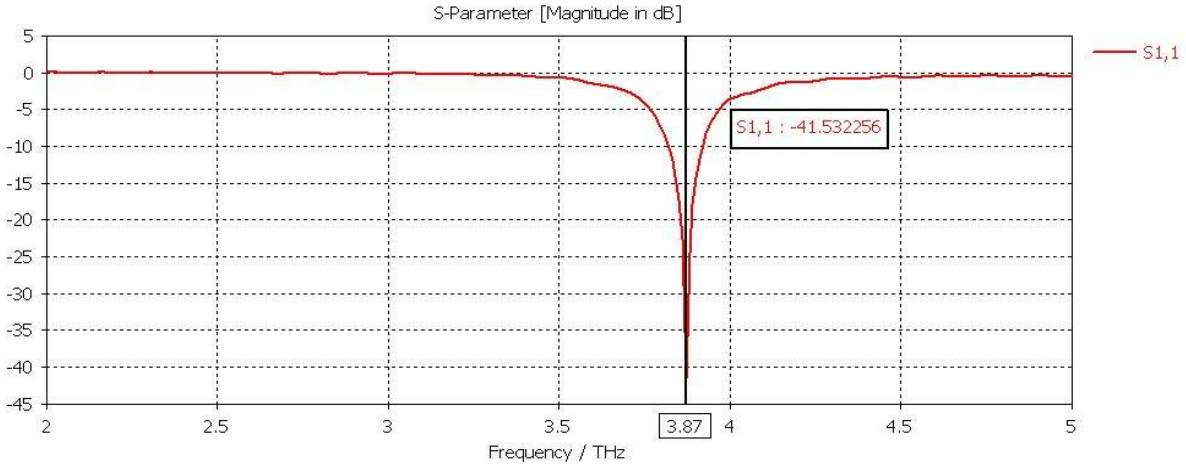

Fig. 4 Return loss plot of the proposed antenna

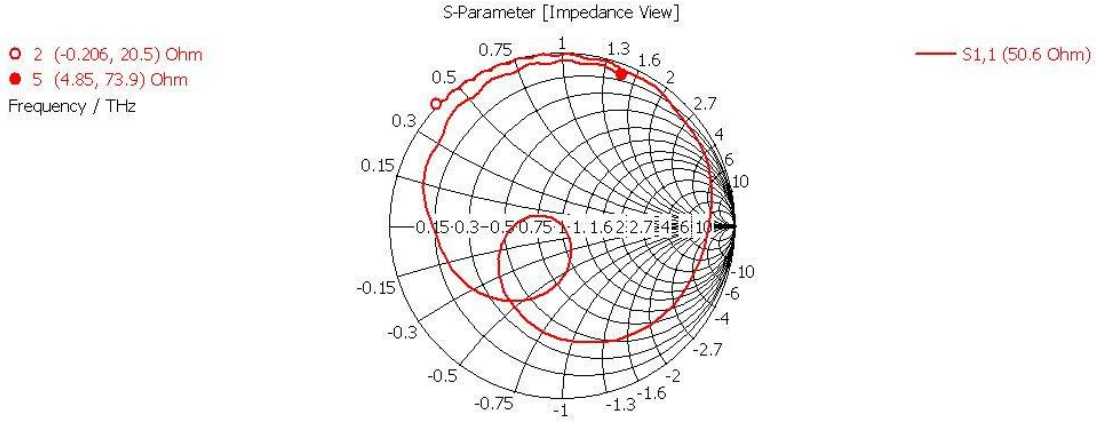

Fig. 5 Smith chart plot of the proposed antenna

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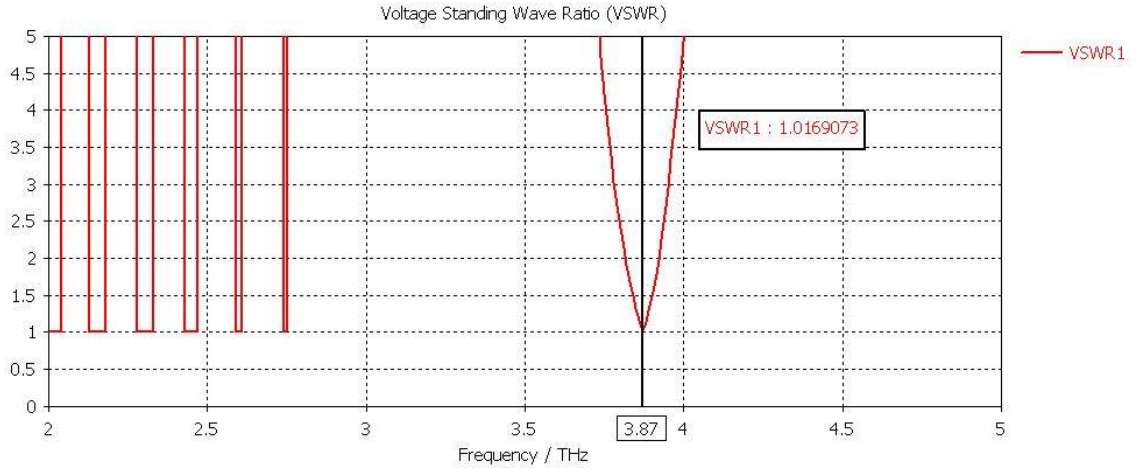

Fig. 6 Voltage Standing Wave Ratio plot of the proposed antenna

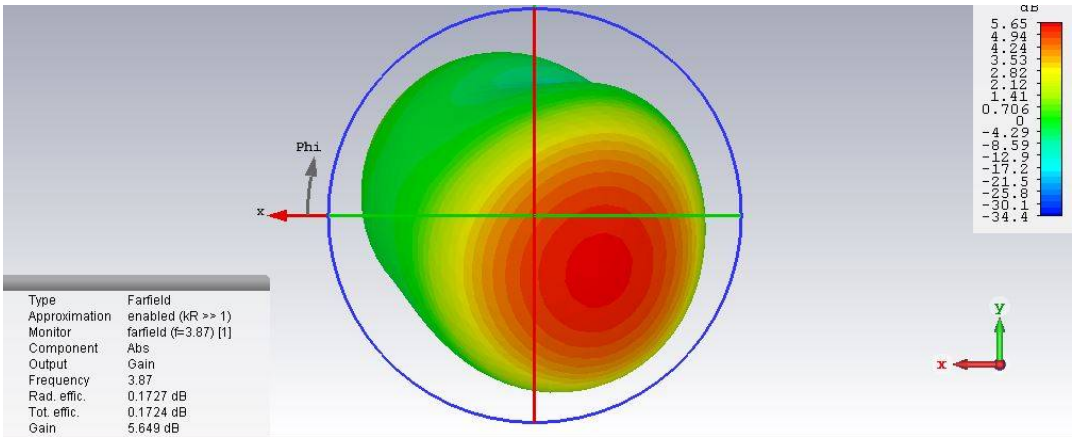

Fig. 7 3-D gain plot of the proposed antenna

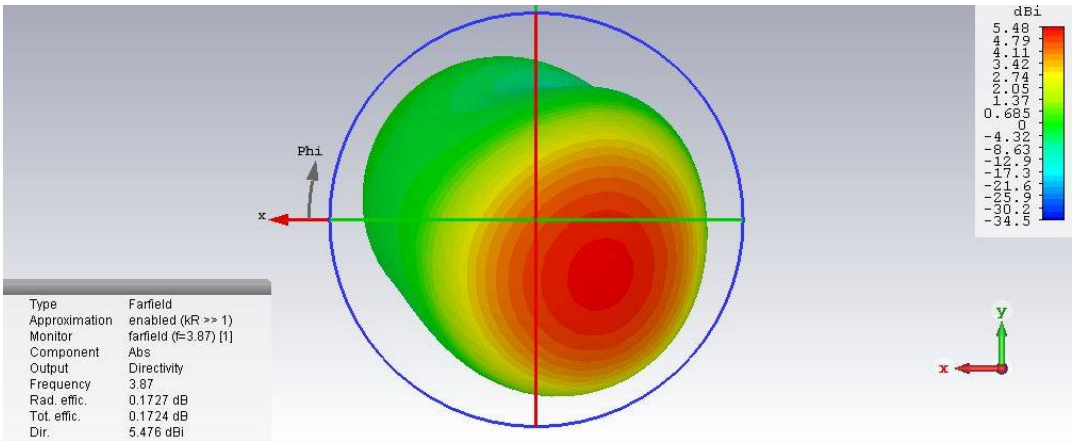

Fig. 8 Directivity plot of the proposed antenna

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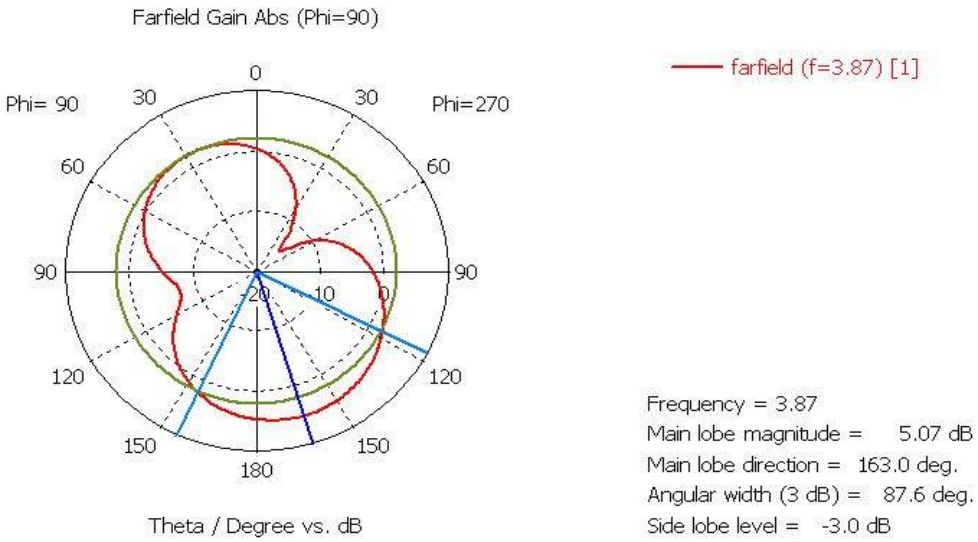

Fig. 9 Half Power Beamwidth plot of the proposed antenna

Table 2.SIMULATED RESULTS OF THE ANTENNA

S.no.	Parameter	Value
01.	Return loss	-41.53 dB
02.	Impedance	50.6Ω
03.	Gain	5.649 dB
04.	Directivity	5.476 dBi
05.	Bandwidth	99.8 GHz
06.	VSWR	1.01
07.	Half Power Beamwidth	87.6 deg

IV.CONCLUSION

The proposed terahertz antenna has been designed and simulated using Computer Simulation Technology Microwave Studio 2016. It has been observed that the designed antenna is resonant at 3.87 THz which matches exactly with the peak absorption frequency value of Vitamin K2. Therefore, the proposed antenna can be used for the detection of Vitamin K2 applications.

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REFERENCES

[1] J. S. Belrose, Fessenden and Marconi: Their differing technologies and transatlantic experiments during the first decade of this century,in Proc. Int. Conf. 100 Years Radio, 1995.
[2] Z. Ying, Antennas in cellular phones for mobile communications, in Proc. IEEE, vol. 100, no. 7, pp. 2286–2296, 2012.
[3] P. Hall, P. Gardner and G. Ma, Active integrated antennas, IEICE Trans. Commun., vol. E85-B, no. 9, pp. 1661–1667, 2002.
[4] B. S. V. S. K. S. a. D. Vijay Sharma, Modified Rectangular Patch Antenna with Air-Gap for Improved Bandwidth, International Conference on Microwave- 08.doi: 10.1109/AMTA.2008.4763098
[5] F. Alizadeh, C. Ghobadi, J. Nourinia and R. Zayer, BandwidthEnhancement of patch antennas loaded with complementary splitting resonators, Telecommunications (IST), Tehran, 2014.doi:10.1109/ISTEL.2014.7000702
[6] R. Bhatoa, Roopan and E. Sidhu, Novel high gain air gap directive antenna for X-band satellite to earth downlink applications, 2016 International Conference on Control, Computing, Communication and Materials (ICCCCM), Allahabad, 2016, pp. 1-4.
doi: 10.1109/ICCCCM.2016.7918223
[7] R. Goyal and Y. K. Jain, Compact bow shape microstrip patch antenna with different substrates, Information & Communication Technologies (ICT), 2013 IEEE Conference on, JeJu Island, 2013.
doi: 10.1109/CICT.2013.6558063
[8] D. Mittal, A. Kaur, L. Singh, A. Sharma and E. Sidhu, Performance analysis of microstrip patch antenna using CSRR and PSRR techniques for WLAN, WiMAX, Wi-Fi and IMT applications, 2016 International Conference on Wireless Communications, Signal Processing and Networking (WiSPNET), Chennai, 2016, pp. 2085-2089.
doi: 10.1109/WiSPNET.2016.7566509
[9] Roopan, R. Bhatoa and E. Sidhu, High gain stacked microstrip folded dipole Yagi antenna configuration for WiMAX applications, 2016 International Conference on Wireless Communications, Signal Processing and Networking (WiSPNET), Chennai, 2016, pp. 1013-1017.
doi: 10.1109/WiSPNET.2016.7566289
[10] M. A. Motin, M. I. Hasan and M. S. Islam, Design and simulation of a low cost three band microstrip patch antenna for the X-band, Ku-band and K- band applications, in in Electrical & Computer Engineering (ICECE), 2012 7th International Conference on, Dhaka, 2012.
doi: 10.1109/ICECE.2012.6471571
[11] L. T, S. K, C. S, B. T and R. H, Visualization and classification in biomedical terahertz pulsed imaging,Phys. Med. Biol., 2002.
[12] C. R. H and C. R. H, Effects of THz exposure on human primary keratinocyte differentiation and viability, J. Biol. Phys., 2003.

BIOGRAPHY

Roopan is an undergraduate student at Department of Electronics and Communication Engineering, Punjabi university, Patiala. She is Pursuing Bachelor of Technology (B.tech 3rd year) in Electronics and Communication Engineering. Her area of interest is Microwave and Terahertz Antenna. She has published papers in the field of MicrowaveAntennas, Optical Antennas and Terahertz Antenna. She is student member of IEEE and ASME.

RaveenaBhatoa is a student at Department of Computer Engineering, Punjabi University, Patiala. She is pursuing her Bachelor of Technology (B.Tech 3rd Year) in the field of Computer Science and Engineering from Punjabi University. Her area of technical interest is Antenna Systems.She is student member of IEEE.

Ekambir Sidhu is an Assistant Professor at Department of Electronics and Communication Engineering, Punjabi University, Patiala. He completed his Masters of Engineering from Thapar University, Patiala in June 2012 with distinction (Gold Medallist) and joined Punjabi University as Assistant Professor in September 2012. His area of specialization is Antenna Systemsand he has published papers in the field of Microwave Antennas, Optical Antennas, Embedded Systems, and Energy Harvesting Systems. He is an Associate Member of IETE and member of IEEE.